

Collaborative Research: *in situ* Mitigation of Mercury-Contaminated Groundwater in Kazakhstan

Wendy Davis-Hoover
Research Microbiologist
U.S. EPA National Risk Management Research Laboratory (NRMRL)
(513) 569-7206
davis-hoover.wendy@epa.com

Authors: Wendy J. Davis-Hoover¹, Svetlana A. Abdrashitova², Laura Schmidt Williams³, Elizabeth E. Cameron³, Richard Devereux⁴

¹U.S. EPA Office of Research and Development (ORD), NRMRL

²Institute of Microbiology and Virology, Ministry of Education and Science, Almaty, Kazakhstan

³U.S. State Department, NP/PTR, Bio-Chemical Engagement Team

⁴U.S. EPA ORD, National Health and Environmental Effects Research Laboratory

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The U.S. Environmental Protection Agency (U.S. EPA) OIA receives funding from the U.S. State Department's Bio-Chem Redirect program to engage former Soviet biological and chemical weapons scientists in civilian research in environmental monitoring and remediation. Scientists in the former Soviet Union receive funding through the International Science and Technology Center for collaborative research with scientists from the U.S. EPA/ORD. This research program also enables these countries to develop scientific infrastructures to address their environmental problems. The U.S. EPA is collaborating on a landmark project with scientists in Kazakhstan (K-756) that has investigated the feasibility of using biotechnological approaches to mitigate mercury-contaminated groundwater associated with a now-closed chloralkali plant in Pavlodar, Kazakhstan.

The chloralkali plant operated from 1970 to 1990. High levels of mercury contamination exist within the plant and in a large groundwater plume moving toward a village and threatening contamination of a major river. In order to meet the challenge of containing the plume, it was proposed to develop biofilters containing (1) bacteria capable of sequestering the mercury, making recovery easy, or (2) mercury-resistant anaerobic bacteria that would precipitate the mercury

Initially, mercury-resistant bacteria were isolated from contaminated soils and sediments at the site and characterized for their potential use in the biological treatments. Characterization of isolates addressed two concerns: mercury volatilization and methylation. A high percentage of the isolated aerobic bacteria were resistant to mercury chloride concentrations up to 0.1 mM. These bacteria effectively removed mercury from culture media with little volatilization. Notably, the bacteria grew as well or better at 40 °C as they did at 25 °C. These bacteria are therefore well adapted to the cold temperatures of this site and could be useful in other cold environment applications.

Among the anaerobic bacteria, obligately anaerobic sulfate-reducing bacteria were obtained that efficiently precipitated mercury with sulfide without forming significant levels of methyl

mercury. One facultative anaerobic bacterial isolate produced sulfide, but mercury was not precipitated. Potential mobilization of mercury by facultative anaerobic bacteria has important implications for better understanding mercury transport in aquatic ecosystems.

These mercury-resistant microorganisms are being further characterized for their potential use for *in situ* biological mitigation at this site. While mercury-contaminated groundwater in Kazakhstan and the world is widespread, there are few options available for mitigating the contamination. This research could lead to the development of alternative, cost-effective approaches while also meeting U.S. nonproliferation objectives through science cooperation.